REMARKS

Claims 12-21 are pending; claims 12, 15 and 18 have been amended and claims 20 and 21 are withdrawn from consideration by the examiner.

Support for the amendments to claim 12 can be found, *inter alia*, on page 5, lines 19-22 and lines 35-40; on page 9, lines 25, 28 and in original claims 4 and 7.

The amendments to the specification are believed to overcome the examiner's objections thereto.

The examiner has required restriction under 35 U.S.C. 121 and 372 between

Group I, claims 12-19, drawn to a multitube reaction and

Group II, claims 20-21, drawn to methods of reaction, stating that the inventions listed as Groups I and II do not relate to a single general inventive concept under PCT Rule 13.1 because, under PCT Rule 13.2, they lack the same or corresponding special technical features for the following reasons: claim 1 is either obvious over or anticipated by Ruppel et al. (see U.S. P. 5,821,390; particularly Figure; column 2, lines 3-19; column 6, lines 3-12). Accordingly, the special technical feature linking the two inventions (i.e. a multitube reactor with 10,000 to 50,000 catalyst tubes within an outer wall, a means for introducing and discharging a heat transfer medium, and a tube spacing to tube diameter ratio) does not provide a contribution over the prior art. Therefore, there is no unity of invention and lack of unity is held by the examiner.

Contrary to the examiner's conclusion there is unity of invention between the reaction and its use because the special technical features are not anticipated or made obvious by Ruppel et al. as will be shown in the discussion of the rejection of the claims

4

by Ruppel et al. Therefore, the examiner is requested to withdraw the restriction requirement. It is assumed that claims 20 and 21 will be rejoined and allowed if claims 12-19 are allowed. Applicants' confirm the election of claims 12-19.

Claims 12 and 19 stand rejected as being anticipated by Ruppel et al. (U.S. 5,821,390).

The examiner holds that a ratio t/d_a in a range of 1.1 - 2.1 is known from Ruppel. However, it is noted that this alleged teaching is not explicitly disclosed but calculated by the examiner using arbitrary values of tube spacing, internal diameter and wall thickness of the catalyst tubes. Ruppel is silent as to whether all theoretically possible ratios should in fact be used. Instead, the only ratios actually disclosed, namely those of the examples of Ruppel correspond to 1.28 or less and are therefore well below the lower limit mentioned in new claim 12. It is therefore submitted that Ruppel does teach to arrange the tubes in a manner that the ratio t/d_a is within the specific range of new claim 12. Thus, there is no anticipation since there is no single embodiment within Ruppel disclosing any overlapping range or a value within the claimed range of 1.3 to 1.6. The rejection is actually based on the examiner's belief that values within the range are <u>obvious</u> in view of the calculations. Accordingly, this rejection should be withdrawn.

In fact, while Ruppel merely recites typical wall thickness and internal diameter ranges of the tubes on the one hand and typical tube spacing on the other hand, a person skilled setting up an industrial scale reactor would select dimensions such that a maximum throughput can be obtained. Such an approach will lead to t/d_a ratios well

below 1.3 as clearly demonstrated by Example 1 of Ruppel.

Claims 13-16 stand rejected as being obvious over Ruppel in view of Westerman et al. (U.S. 4,894,205) while claims 12, 17 and 19 stand rejected as being obvious over Groten et al. (U.S. 5,730,843) in view of Ruppel et al.

This rejection assumes either that (1) Ruppel discloses t/d_a ratios of 1.1 to 2.1 or (2) it would have been obvious to use the Ruppel reactor having said t/d_a ratios. As indicated above, the claimed ratios are not disclosed under 35 USC 102(b).

The claimed ratio is also not obvious from Ruppel.

Contrary to what a person skilled in the art would normally try to achieve, namely to arrange the tubes as closely as possible (c.f. Example 1 of Ruppel), the present invention teaches to arrange the tubes no closer than down to a t/d_a ratio of 1.3. In fact, Ruppel does not teach that a particular ratio of t/d_a is of any importance.

As compared with ratios below 1.3 as known from Ruppel, selecting a lower limit of 1.3 according to the present invention allows higher heat transfer medium flow without having to increase pump power. Higher heat transfer medium flow allows to increase the load of gaseous reactants and to fully benefit from employing modern highly efficient catalyst materials. Thus, the increased heat generated by an increased load of reactants can easily be withdrawn from the reactor of the present invention without leading to an increased energy consumption for operating the pumps.

Further, a higher heat transfer medium flow leads to a more uniform temperature distribution across the reactor cross section and to a reduction in the hot spots. This allows for an increase of the inflow temperature of the heat transfer medium without

exceeding the maximum permissible exit temperature which leads to an improved selectivity of the reaction and consequently to an increase of yield of up to 2% (c.f. page 4, lines 30-35 of the present specification.)

The upper limit of the t/d_a ratio in claim 12 is selected to avoid an undue increase of the external diameter of the reactor (for a given number of tubes).

Within the claimed range from 1.3 and 1.6, manufacturing costs of a reactor will decrease due to the fact that arranging the catalyst tubes less tightly packed is technically less demanding. This cost effective manufacturing process will even allow to compensate for slightly increased material costs, if any, which are due to an increased diameter of the reactor (for a given numbers of tubes).

Neither Ruppel nor Westerman (U.S. 4,894,205) nor Groten (U.S. 5,730,843) nor the general knowledge of a person skilled in the art suggest that selecting a t/d_a ratio as defined in claim 12 will lead to an increased product yield while maintaining both the manufacturing costs and the operational costs practically unchanged or even as compared to the reactors of prior art. Thus, the claimed process leads to unexpected results over the art of record.

Additionally, it was further surprisingly found, that the beneficial effects obtained by selecting a certain t/d_a ratio as outlined above are most notable when the heat transfer medium is essentially conveyed radially or transversely around the catalyst tubes. Thus, this additional limitation has been added in amended claim 12.

Finally, regarding Westerman which has been cited against claims 13-16, it is noted that Westerman is not at all concerned with the effects of increased bundle

OLBERT et al., Ser. No. 09/936,354

diameter on the ratio t/d_a. In the example of col. 1, lines 52-56 cited by the examiner, the bundle diameter (essentially corresponding to the diameter of the reactor) remains constant (5 m) and does not teach anything on its effect on t/d_a ratio.

In fact, it is not readily apparent to one skilled in the art why the t/d_a ratio should vary at all with increasing bundle diameter.

The subject matter of claim 13, increasing tube spacing, facilitates the heat transfer in larger multitube reactors and results in a more uniform temperature over the cross-section. Claim 13 is thus clearly patentable over Westerman in view of Ruppel.
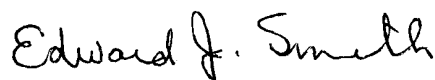
The unobviousness of the claimed ratio t/d_a can be shown in a Rule 132 declaration if the examiner deems that such a declaration would be helpful.

Favorable action by the examiner is solicited.

A check for $950.00 is attached for a three month extension of time. Should this be deficient, kindly charge Deposit Account No. 11-0345.

Respectfully submitted,

KEIL & WEINKAUF

Edward J. Smith

Edward J. Smith
Reg. No. 24,074

1350 Connecticut Ave., N.W.
Washington, D.C. 20036

(202)659-0100

8

Page 1, line 12, insert

Background of the Invention

Page 3, line 42, insert

Summary of the Invention

Page 7, line 25, insert

Brief Description of the Drawings

Page 8, line 6, insert

Description of the Preferred Embodiments

Page 4, first paragraph, line 2, please rewrite the paragraph as follows:

We have found that this object is achieved by the multitube reactor described herein ~~having the features of claim~~. According to the present invention, it is proposed that in the case of relatively large reactors in which a large amount of heat of reaction is generated owing to the numerous catalyst tubes and has to be removed, the ratio of tube spacing t to external tube diameter d_a be made dependent on the reactor diameter or on the external tube bundle diameter d_{RBa}. In particular, the present invention proposes providing a ratio of tube spacing t to external tube diameter d_a of at least 1.3. Preferably, the catalyst tubes are arranged such that three adjacent tubes form a triangle, preferably a equilateral triangle. In this case, tube spacing t is equal to the length of the sides of the triangle.

Page 8, line 1 of paragraph 2, please rewrite as follows:

Figure 8   shows a longitudinal section of a ~~forth~~ <u>fourth</u> embodiment of the reaction

of the present invention.

Page 10, last paragraph, line 21, please rewrite the paragraph as follows:

Finally, Figure 8 show a schematic longitudinal section of a ~~forth~~ <u>fourth</u>

embodiment of the multitube reactor of the present invention. In this embodiment,

reactor 35 is a two-zone reactor which is, in the longitudinal direction of the catalyst

tubes 17, divided into two zones 36, 37 maintained at different temperatures. Zones 36

and 37 are supplied by separate heat exchange circuits. In the example depicted, a

first salt solution is introduced via fittings 38, 39 into the first zone 36 and withdrawn

therefrom via fitting 40, 41. Correspondingly , a second salt solution is introduced via

fittings 42, 43 into the second zone and withdrawn therefrom via fittings 44, 45. Both

zones 367, 37 are separated from each other by means of a tube sheet 46 having a

thickness of 50 mm. The sheet comprises openings through which the catalyst tubes

17 are inserted. After insertion, the tubes are widened hydraulically to some extent so

as to provide for a good and largely leak-tight fit of the tubes 17 in tube sheet 46. In

each zone baffle plates 47 are provided for guiding the salt melt radially from an outer

region to the center of the reactor which is free from catalyst tubes, where the melt is

directed upwards to be then again directed to the outer region of the reactor. In Fig. 8,

large arrows 48 indicate the flow direction of reaction gases while smaller arrows 49, 50

indicate the flow of the salt melt.

COPY OF ALL CLAIMS IN THE CASE

12.   (currently amended) A multitube reactor (13) which has a catalyst tube bundle

(18) comprising numerous parallel catalyst tubes (17) arranged within an outer

wall (15), said catalyst tube bundle (18) having from 10,000 to 50,000 catalyst

tubes (17), and having means for introducing and discharging a heat transfer

medium said means being adapted such that the heat transfer medium is

essentially conveyed radially or transversely around the catalyst tubes, optionally

redirected to assume a meandering path, flowing around the catalyst tubes (17),

wherein the ratio t/d_a of tube spacing t to the external diameter d_a of a catalyst

tube is at least 1.3 is in the range from 1.3 to 1.6.

13.   (previously presented) A multitube reactor as claimed in claim 12, wherein the

ratio t/da of tube spacing t to the external diameter d_a of a catalyst tube (17) rises

with increasing transverse dimensions of the catalyst tube bundle (18).

14.   (previously presented) A multitube reactor as claimed in claim 12, wherein the

catalyst tube bundle (18) has an essentially circular cross section having an

external diameter d_{RBa} of more than 4 m.

15.   (currently amended) A multitube reactor as claimed in claim 14, wherein the

external diameter d_{RBa} of the catalyst tube bundle (18) is from 4 m to 1 m and the

ratio t/d_a of tube spacing t to the external diameter d_a of a catalyst tube (17) is in

the range from 1.3 to 1.6.

16.   (previously presented) A multitube reactor as claimed in claim 15, wherein the

external diameter d_{RBa} of the catalyst tube bundle (189) is from 4 m to 10m and

the ratio t/d_a of tube spacing t to the external diameter d_a of a catalyst tube (17) is in the range from 1.3 to 1.5.

17. (previously presented) A multitube reactor as claimed in claim 12, wherein the catalyst tube bundle (18) has an essentially rectangular cross section with a tube bundle depth d_{RBt} measured parallel to the flow direction of the heat transfer medium of at least 1.3 m.

18. (currently amended) A multitube reactor as claimed in cl1im in claim 17, wherein the depth d_{RBt} of the catalyst tube bundle (18) is from 1.3 to 4 m ~~and the ratio~~ ~~t/da of tube spacing t to the external diameter d_a of a catalyst tube (17) is in the~~ ~~range from 1.3 to 1.6~~.

19. (previously presented) A multitube reactor as claimed in claim 12, wherein the reactor is divided, in the longitudinal direction of the catalyst tubes (17), into a least two zones (36,37), with a flow of heat transfer medium of different temperature being provided in each zone.

20. (previously presented) A method for carrying out catalytic gas-phase reactions, said method comprising the use of a multitube reactor as claimed in claim 12.

21. (previously presented) A method for carrying out oxidation reactions, in particular for the preparation of phthalic anhydride, maleic anhydride, acrylic acid, acrolein, methacrylic acid, glyoxal, phosgene, hydrocyanic acid or vinyl formamides, said method comprising the use of a multitube reactor as claimed in claim 12.